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SOME NEW AMERICAN SPECIES OF CYCLUS FROM THE COAL MEASURES, *Austin F. Rogers.*

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SOME NEW AMERICAN SPECIES OF CYCLUS FROM THE COAL MEASURES.

BY AUSTIN F. ROGERS.

With Plate XIV.

The xiphosuran genus *Cyclus*, founded upon *Agnostus? radialis* Phillips, by De Koninck, in 1841, is now represented by fourteen European species—eleven from the Coal Measures of Great Britain, (one species of which is also known from Belgium), one from the Permian of Sicily, and two from the Muschelkalk (Triassic) of Germany. A single American species, *C. americanus* Packard, has been described from the Lower Coal Measures of Mazon creek, Illinois, and as far as can be learned this is the only occurrence mentioned of the genus in this country.

During the past few years the writer has collected from the Upper Coal Measure limestones of western Missouri and eastern Kansas a considerable number of specimens of this interesting genus which are referred to five new species herein described. They occur for the most part in the Iola limestone* at Kansas City, Mo., associated with typical Coal Measure fossils.†

Of especial interest is the discovery of the compound eye in *Cyclus*. This I have found in several specimens of one of the species, *Cyclus communis*, n. sp., *postea*. It is rather large, oval or elliptical in shape, and is situated near the anterior lateral border (see figure 1*a*). In one specimen the facets are, with the aid of a compound microscope, plainly seen to be hexagonal in outline and greatly resembling those of a trilobite. The simple eye (sometimes stalked) has been noted by Woodward and other observers, but as far as can be learned this is the first mention of a compound eye.

*No. 98, Broadhead's Gen. Sect. Coal Meas. Rocks of Missouri.

†For a full list of the fossils of this limestone, see a paper by the author, "Coal Measure Faunal Studies, I," this journal, vol. IX, pp. 245–247, 1900.

Generic Diagnosis of Cyclus De Koninck, 1841.

Cephalothorax small, disk-shaped to subhemispherical, bilaterally symmetrical, usually with a median ridge posteriorly, circular to elliptical or oval in outline; ornamentation consisting of lobes, ribs, "forks," or nodes, often with granules occupying more or less of the surface of the carapace; border entire, or with posterior projection or indentation; margin usually present, varying in width and character; compound eyes oval, situated at the antero-lateral border, much resembling those of a trilobite; appendages nearly as in those of embryonic *Limulus*.

Cyclus communis, n. sp. Plate XIV, figs. 1, 1*a*.

Carapace subhemispherical, circular in outline. Lateral profile view a semioval, the highest point being a little back of the center of the carapace. Border entire, with a narrow, nearly vertical margin, which is separated from the main part of the carapace by a shallow furrow. A narrow, inconspicuous median ridge extends from the posterior margin to the center of the carapace. On each side of its anterior half is a narrow furrow, each of which on reaching the end of the ridge continues in an antero-lateral direction for a short distance and then again becomes parallel to the median ridge. The diverging furrows thus form a polygonal area, open anteriorly. Within this area are situated three inconspicuous very slight elevations, which are symmetrically disposed with reference to the median line of the carapace, a single unpaired one posterior to the paired anterior ones, all approximately equal in size. The surface of the carapace is thickly covered with rather coarse granulations, with the exception of the anterior portion, which is almost smooth. In one specimen the coarse granulations and their interspaces are occupied by still finer granulations. On the antero-lateral border is a prominent oval or elliptical-shaped compound eye with distinct facets.

Measurements.	Eudora specimen.	Kansas City specimen.
Length	6 mm.	$4\frac{1}{2}$ mm.
Width	6 mm.	$4\frac{1}{2}$ mm.
Height	$2\frac{1}{2}$ mm.	$2\frac{1}{4}$ mm.
Width of margin	.....	$\frac{1}{2}$ mm.
Compound eye	.....	$\frac{1}{2}$ mm. $\times$ $\frac{3}{4}$ mm.

Position and locality: Upper Coal Measures, Iola limestone, Kansas City, Mo.; Lower Garnett limestone,* Eudora, Douglas county, Kansas. Many specimens.

This species resembles in several respects *C. jonesianus* H. Woodw. but presents the following differences: It is a little smaller; is circular in outline instead of elliptical; the anterior part of the carapace

*For the other fossils occurring in this limestone, see paper by the author, l. c.

is smooth, and the granulations are more prominent than in *C. jonesianus*.

C. communis is much more abundant than the other species here described, though good specimens are rare. About eighty specimens, most of them very imperfect, were obtained from the Iola limestone, whereas from only one to three specimens of the other species were obtained. Some of the specimens are quite small and not nearly so tumid as the types. These may possibly represent another species, but it is more probable that they are young or stunted forms.

Cyclus packardi, n. sp. Plate XIV, figs. 2, 2*a*.

Carapace rather flat, decidedly shield-like, transversely subelliptical in outline. The edge of the carapace is concealed by the matrix, so that it cannot be said whether or not a margin is present. A well-defined median ridge reaches from the posterior border to the center of the carapace, where it expands into a small subcircular prominence, with a slight horizontal carina. Directly in front of the expansion is a quinquelobate prominence, consisting of a median anterior lobe and two paired posterior ones. Of these lobes, the middle or anterior paired ones are the largest and project laterally over the others. The posterior pair are occupied with several transverse ribs. Arising on each side of the median ridge, near its middle, is a ridge extending toward the antero-lateral border, where it expands to form a prominent oval-shaped lobe. Distad of this last-mentioned ridge and separated from it by a narrow furrow is a sharp, narrow ridge also extending antero-laterally, but after a short distance it curves forward, crossing the other ridge, and then expands to form a subtriangular lobe, which is but a short distance from the lateral surface of the quinquelobate prominence. These ridges are the "inner fork" and "outer fork" of Reed.*

The more elevated parts of the carapace, with the exception of the quinquelobate prominence and the median ridge, are covered with small tubercles which are sometimes rather prominent.

Measurement.	Largest specimen.	Smallest specimen.
Length	$7\frac{1}{2}+$ mm.	$5\frac{1}{2}$ mm.
Breadth	11 mm.	8 mm.
Height	(cannot be determined.)	

Position and locality: Upper Coal Measures, Iola limestone, Kansas City, Mo. Three specimens.

C. packardi does not resemble any other described species of the genus. In the disposition of the "inner" and "outer forks" it is a

*Geol. Mag., vol. X, p. 64, 1893.

little like *C. woodwardi* Reed, but the ribs on the latter species give it an entirely different appearance. The lobes on the anterior part of the carapace are quite different in number and character.

Cyclus permarginatus, n. sp. Plate XIV, fig. 3.

Carapace rather flat, disk-shaped, subcircular in outline, with a wide margin. A faint, interrupted median ridge extends along in a shallow furrow from the posterior border to a point near the center of the carapace. At the latter point the furrow divides dichotomously and the branches proceed in an antero-lateral direction, the whole forming an indistinct, Y-shaped depression. On each side of the median ridge or furrow are situated six or seven ribs reaching to the margin. The posterior ribs have an oblique direction, and are more prominent than the anterior ones, which can scarcely be recognized except near the border.

The anterior surface of the carapace bears several slight elevations, but nothing definite concerning them can be made out. A wide, flat, smooth margin extends around the lateral and posterior borders. The anterior border is hidden by the matrix. Only small portions of the outside surface remain. It is apparently occupied by small pits.

Measurements: Length, 7 mm. +; width, 8 mm.; height, 1.5 mm.; width of margin, 1 mm.

Position and locality: Upper Coal Measures, Iola limestone, Kansas City, Mo. Two specimens.

The margin of this species is relatively wider than that of any other described species of the genus. It is more like *C. americanus* Packard than any of the other species herein described, but that species is larger, its margin is narrower, and it is apparently not ribbed.

The radiating ribs give our species an appearance somewhat like that of *C. radialis* Phillips, but it is flatter than that species, and its ribs are not nearly so prominent. There is no flattened margin in *C. radialis*. *C. permarginatus* bears some resemblance to a specimen from Ayrshire, figured by Woodward* and referred by him to *C. radialis*. He states that the specimen is imperfect around the border. If we add a border of one millimeter, the measurements will be quite near those of our species, but as no profile view is given its height cannot be judged. At any rate, our species is not *C. radialis*.

C. harknessi H. Woodw. and *C. woodwardi* Reed are also ribbed, but the prominent lobes on those species give them an aspect entirely different from that of our species. Moreover, they are quite gibbous. There is also some resemblance to *C. johnsoni* H. Woodw., but there

*Geol. Mag., pl. XV, fig. 2 (opposite p. 530), 1894. Measurements: Length, 6 mm.; breadth, 5 mm.

are no ribs, and the margin is not as wide as it is in our species. Besides, in our species the margin is not separated from the body of the carapace by a furrow.

Cyclus limbatus, n. sp. Plate XIV, fig. 4.

Carapace flat, disk-shaped, short transversely elliptical in outline. Margin quite narrow, with a fringe of slender spines which vary in size and length. About twelve can be counted on one side of the carapace, but this does not include the anterior border which is partially embedded in the matrix. The spines are flat and pointed at the end. The largest and longest one occurs at the middle of the lateral border. There is a slight posterior median projection of the carapace, and from the appearance it seems that a spine was broken off here. If such be the case we have here in *Cyclus* the embryotype of *Limulus*, suggestions of some of the characters of the latter genus, namely, the telson and the genal spines.

The ornamentation of the carapace consists of a series of small, inconspicuous nodes surrounding the postero-lateral borders. Centrad of these is another row, made up of ill-defined elongate nodes slightly larger than the last-mentioned ones. Next is a pair of low ridges or a "fork," near the anterior end of each of which is a rather large oval lobe, perhaps the most conspicuous feature of the carapace. At the anterior border, near its middle, there is on each side a smaller lobe, and in the V-shaped space, between these and the fork, are several very inconspicuous elevations.

Measurements: Length, 3 mm.; width, 3.5 mm.; height, 0.75 mm.; length of longest spine, 0.5 mm.

Position and locality: Upper Coal Measures, Iola limestone, Kansas City, Mo. One specimen.

This species is unique in the possession of a fringed margin.

Cyclus minutus, n. sp. Plate XIV, fig. 5.

Carapace very small, longitudinally elliptical in outline, rather flat, and apparently without a margin. A narrow, rather sharp median ridge extends from the posterior border nearly one-half the length of the carapace. Distad of the anterior part of the median ridge there are on each side two other ridges wider than the median one. There the "inner fork" and the "outer fork" of Reed and their expanded anterior ends are much like those of *C. packardi*, n. sp., *antea* (the description of which see). Partly enclosed by the inner fork and in front of the median ridge are slightly elevated nodes, a posterior median one and two paired anterior ones. Around the anterior border are three inconspicuous nodes smaller than those just mentioned. There is a median anterior one and two paired posterior ones.

Measurements: Length, 1.8 mm.; width, 1.25 mm.; height, 0.5 mm.

Position and locality: Upper Coal Measures, Iola limestone, Kansas City, Mo. Three specimens.

This is the smallest described species of the genus. In some respects it resembles *C. packardi*, n. sp., *antea*, and may possibly be a young form of that species. But in the absence of intermediate forms, and as the specimens seem to be perfectly formed, it is designated as a distinct species.

Our species also resembles *C. jonesianus* H. Woodw., but it is much smaller, less tumid, the arrangement of the anterior lobes is different, and the furrow separating the inner and outer forks is much more prominent.

Analytic Key to the American Species of the Genus *Cyclus*.

1. With ribs. Wide, flat margin ..... *permarginatus.*
   Without ribs 2
2. Circular or subcircular in outline 3
   Transversely elliptical in outline 4
   Longitudinally elliptical in outline, carapace very small ..... *minutus.*
3. Subhemispherical, with narrow, nearly vertical margin ..... *communis.*
   Disk-shaped, with wide, horizontal margin ..... *americanus.*
4. Carapace rather large, surface with lobes and small tubercles .... *packardi.*
   Carapace small; surface with lobes but no tubercles; fringed margin ..... *limbatus.*

Alphabetical List of Described Species of the Genus *Cyclus*, with Synonomy.

Cyclus agnotus von Meyer.
Halicyne agnotus von Meyer, 1847.
Cyclus agnotus H. Woodw., 1870.

Cyclus americanus Packard.
Cyclus americanus Packard, 1885, 1886.

Cyclus bilobatus H. Woodw.
Cyclus bilobatus H. Woodw., 1870, 1878.

Cyclus harknessi H. Woodw.
Cyclus harknessi H. Woodw., 1870, 1878.

Cyclus johnsoni H. Woodw.
Cyclus johnsoni H. Woodw., 1894.

Cyclus jonesianus H. Woodw.
Cyclus jonesianus H. Woodw., 1870, 1878, 1894.

Cyclus laxus von Meyer.
Halicyne laxus von Meyer, 1847.
Cyclus laxus H. Woodw., 1870.

Cyclus radialis Phillips.
Agnostus? radialis Phillips, 1836.
Cyclus radialis De Koninck, 1841, 1842; H. Woodw. and Salter, 1865; H. Woodw., 1868, 1870, 1894.

Cyclus rankini H. Woodw.

Cyclus rankini H. Woodw., 1868, 1870, 1878.

Cyclus reussi Gemmellaro.

Paraprosopon reussi Gemmellaro, 1890.
Cyclus reussi Frech, 1900.

Cyclus scotti H. Woodw.

Cyclus scotti H. Woodw., 1893, 1894.

Cyclus testudo Peach.

Cyclus testudo Peach, 1883; H. Woodw., 1894.

Cyclus torosus H. Woodw.

Cyclus torosus H. Woodw., 1870, 1878.

Cyclus woodwardi Reed.

Cyclus woodwardi Reed, 1893; H. Woodw., 1894.

Cyclus wrighti H. Woodw.

Cyclus wrighti H. Woodw., 1870, 1878.

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Woodward, H., 1893.—Geol. Mag. (3), vol. x, p. 28, 2 text figures.
Woodward, H., 1894.—Geol. Mag. (4), vol. I, p. 530, pl. xv, ff. 1–8, and 3 text figures.
Woodward, H. (and Salter, J. W.), 1865.—Cat. and Chart. Foss. Crustacea, p. 15, f. 14.

In conclusion, I wish to thank Mr. Gilbert Van Ingen for aid in the preparation of this paper.

COLUMBIA UNIVERSITY, IN THE CITY OF NEW YORK,
FEBRUARY 10, 1902.

Explanation of Plate.

(The pointed end of the arrows on the plate indicates the anterior ends of the carapace.)

FIG. 1. *Cyclus communis* Rogers.

1. Dorsal view of carapace. × 6.

1*a*. Profile view of carapace (diagrammatic), showing position of facetted eye and slight groove separating margin from carapace proper. × 7.

FIG. 2. *Cyclus packardi* Rogers.

2. Dorsal view of carapace. × 3.

2*a*. Dorsal view of portion of carapace of another specimen, showing surface detail; the broken parts of the carapace overlap. × 6.

FIG. 3. *Cyclus permarginatus* Rogers.

3. Dorsal view of carapace. × 6.

FIG. 4. *Cyclus limbatus* Rogers.

4. Dorsal view of carapace. × 7.

FIG. 5. *Cyclus minutus* Rogers.

5. Dorsal view of carapace. × 7.
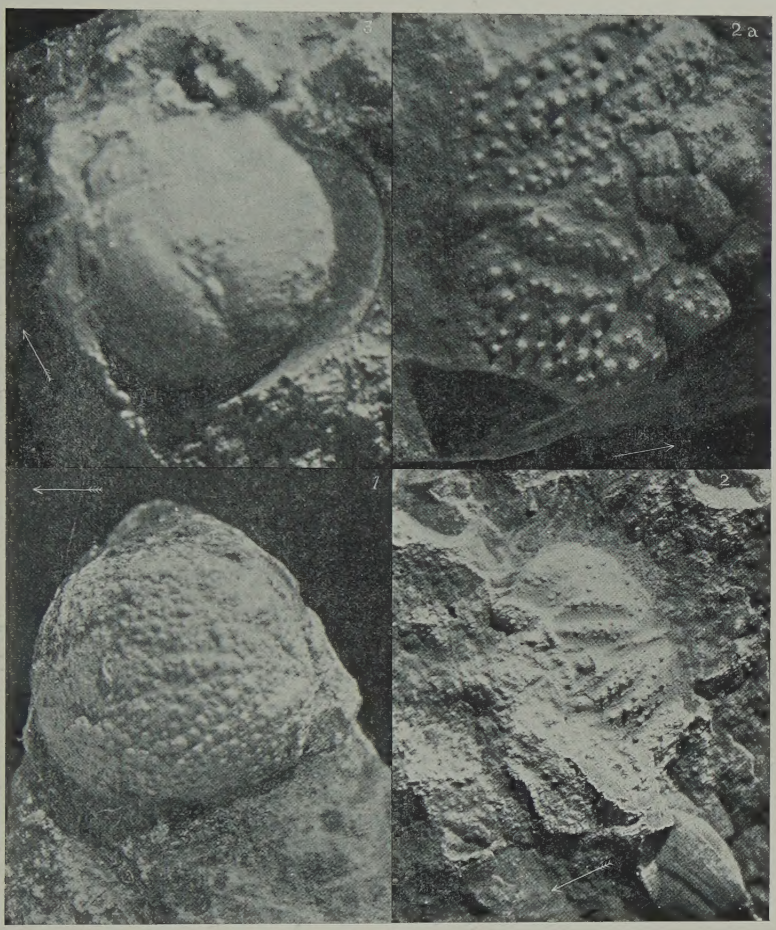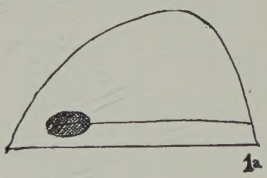
PLATE XIV.